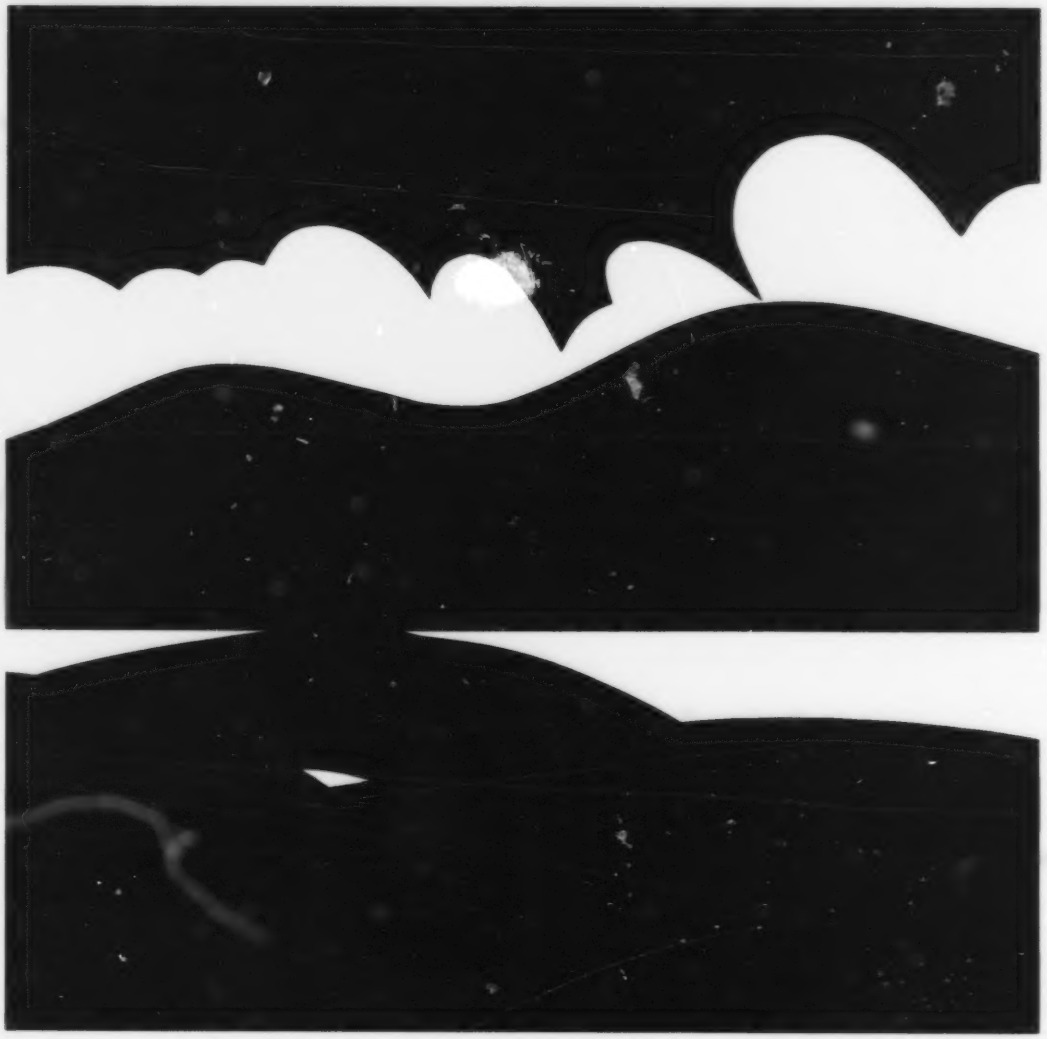
BAPTISTE LAKE



Alberta
ENVIRONMENT

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Lakes attract people. And people want to know why "their" lake is the way it is — why is it so green in July? Is the water quality really deteriorating? How do our activities affect the lake?

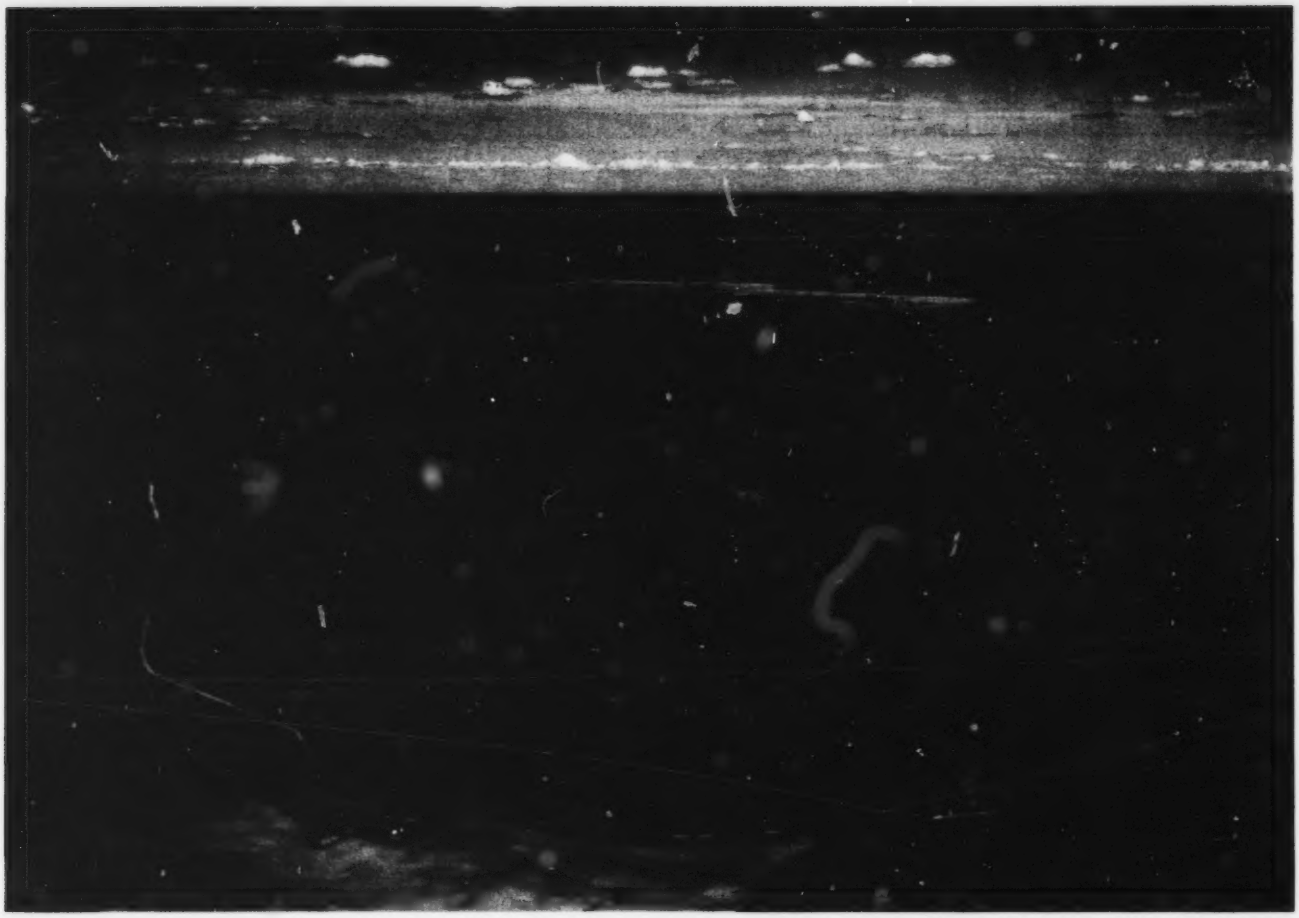
This brochure, one of a series on Alberta's lakes, attempts to answer these questions by presenting findings of water quality studies conducted by the Environmental Assessment Division of Alberta Environment.

As you read through the brochure, you may find that you have questions about the concepts and illustrations. At the end is a section called **Explanation of Lake Characteristics**. Refer to this for further interpretation.

Brochures are available for the following lakes:

Sandy Lake	Pine Lake	Lac la Biche
Lac la Nonne	Garner Lake	Nakamun Lake
Wizard Lake	Skeleton Lake	Lac Ste. Anne
Pigeon Lake	Jackfish Lake	Baptiste Lake

May 1989



Baptiste Lake is an attractive, popular recreational lake located 16 km west of the town of Athabasca in central Alberta. To reach the lake, take Highway 2 west from Athabasca to the point that the highway turns north; proceed west on a local road to the County of Athabasca Recreation Area on the southwest corner of the lake. There are access roads that follow much of the shoreline.

Baptiste Lake was first settled in the 1880s by a group of Metis from Saskatchewan, and the land was surveyed into long narrow lots. The lake was named after Baptiste Majeau, an early settler. By the 1920s most of this land had been sold to homesteaders.[1] Cottage development began in about 1942 in the area of Sunset Beach. There are now five summer villages, with over 500 resort lots (about 420 cottages), along the shoreline of Baptiste Lake. The proportion of permanent residences has increased from about 6% in 1977 to about 14% in 1988.[2] The county operates a public day-use facility on the southwest shore that provides a boat launch, a dock, washrooms, a picnic shelter, a beach and picnic tables. Commercial operations on the south end of the lake provide camping and cabin rental facilities.

Fishing

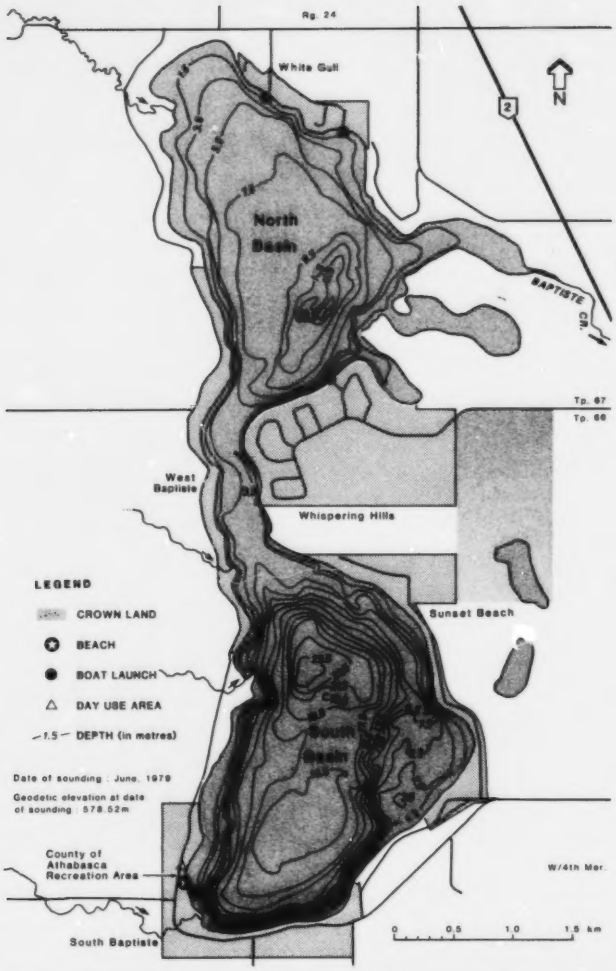
Baptiste Lake receives fairly heavy angling pressure during spring and summer for northern pike (jackfish), walleye and yellow perch. Fishing success is only moderate, although the catch of yellow perch was high during a creel survey in spring, 1982.[3] Baptiste Lake also supports cisco (tullibee), burbot, white suckers, spottail shiners, Iowa darters, brook sticklebacks and ninespine sticklebacks. Weedbeds around the lakeshore provide important spawning and feeding habitat for northern pike and yellow perch. Summerkills of fish rarely occur in Baptiste Lake. A commercial fishery operated on the lake from the early 1900s to 1948, in 1953 and in 1964, mainly to provide cisco to mink farms on Lesser Slave Lake. It has not operated since 1964.

Physical Characteristics

Baptiste Lake is made up of two distinct basins that are separated by a narrow channel (see the Depth Contour map). The lake is fairly deep; the greatest depth is about 25 metres in the south basin and 15 metres in the north basin. Inflow

1. Athabasca Historical Society. 1986. Athabasca Landing: An illustrated history.
2. Alberta Municipal Affairs, Planning Services Division.
3. Berry, D. 1986. An assessment of the spring sport fishery at Baptiste Lake, Alberta 1982. Alberta Forestry, Lands and Wildlife, Fish and Wildlife Division.

Depth Contours of Baptiste Lake



PHYSICAL AND HYDROLOGICAL CHARACTERISTICS

LAKE AREA	km^2	9.81	
DRAINAGE AREA (excluding lake)	km^2	288	
DRAINAGE AREA/ LAKE AREA		29.4	
VOLUME	m^3	84.6	$\times 10^6$
MAXIMUM DEPTH	m	25.5	
MEAN DEPTH	m	8.6	
SHORELINE LENGTH	km	26.4	
TOTAL INFLOW	m^3/yr	20.7	$\times 10^6$
EVAPORATION	m^3/yr	6.26	$\times 10^6$
RESIDENCE TIME	years	6	

Reference: Alberta Environment, Technical Services Division

of water to Baptiste Lake is through several permanent and intermittent streams that drain the lake's large watershed. There is also evidence that a portion of the inflow is via groundwater (springs in the lake). The outflow is Baptiste Creek, which drains east to the Athabasca River.

A history of the water levels since 1960 is shown on the Historical Water Level graph. There have been substantial short-term fluctuations in the level of the lake. The difference between the highest and lowest levels over the period of record was almost two metres. The long-term average trend is stable. No permanent control structures regulate the lake's outflow.

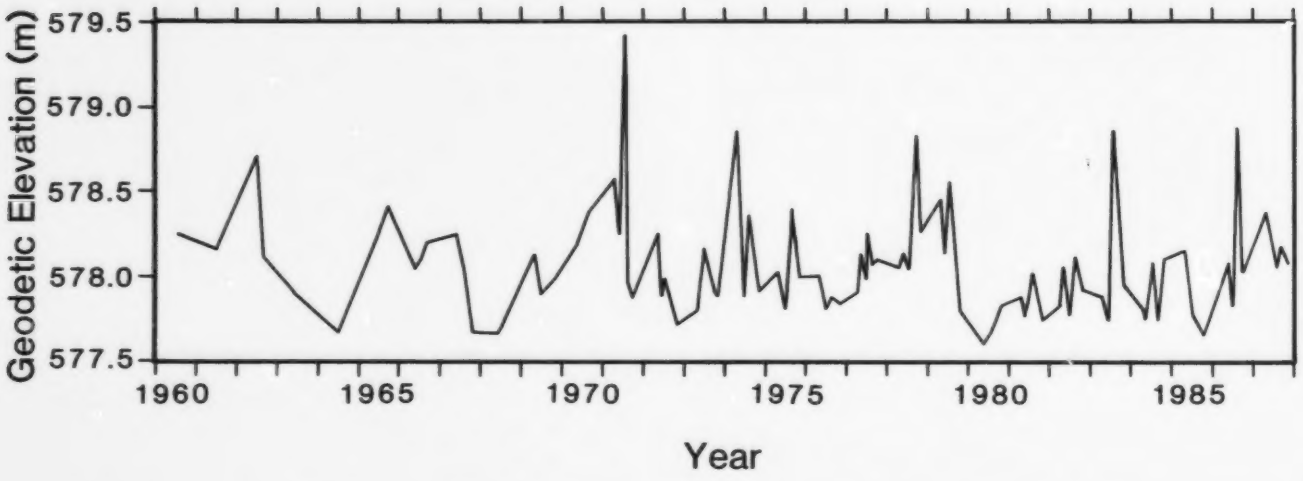
Nutrient Sources

The abundant growth of plants, including algae, in Baptiste Lake is mainly a result of the large quantity of nutrients that are in the lake. The plant nutrient phosphorus is particularly important and is the major determinant of recreational water quality in Alberta lakes.

A detailed study by Alberta Environment from 1976 to 1978 measured the proportions of phosphorus entering Baptiste Lake each year from different sources (see the Theoretical External Phosphorus Supply table).[4] The lake's watershed is very large (see the Watershed map), and surface runoff contributes the largest

4. Trew, D.O., D. Beliveau and E. Yonge. 1978. The Baptiste Lake Study — Summary Report. Alberta Environnment, Pollution Control Division, Water Quality Control Branch.

Historical Water Level of Baptiste Lake



amount of phosphorus. Less than 20% of the watershed has been cleared for agriculture. Further extensive clearing of land for agriculture might be expected to cause a considerable increase in the phosphorus load to Baptiste Lake, because studies have shown that there is much more phosphorus in runoff from agricultural land than from forested areas. Less than 1% of the watershed is developed for cottage and urban use, so it is probable that a relatively small proportion of the phosphorus in the lake is from urban land runoff and septic systems.

The phosphorus input from septic systems has never been measured directly on Baptiste Lake. The value in the table was estimated from studies on other lakes, and updated to present levels of cottage development on Baptiste Lake.

In addition to these "external" sources of phosphorus, the sediment at the bottom of the lake contains phosphorus and is an "internal" source to the lake water. Under certain conditions during the summer, the sediments may release phosphorus to the water, which fertilizes the algae and produces algal blooms.

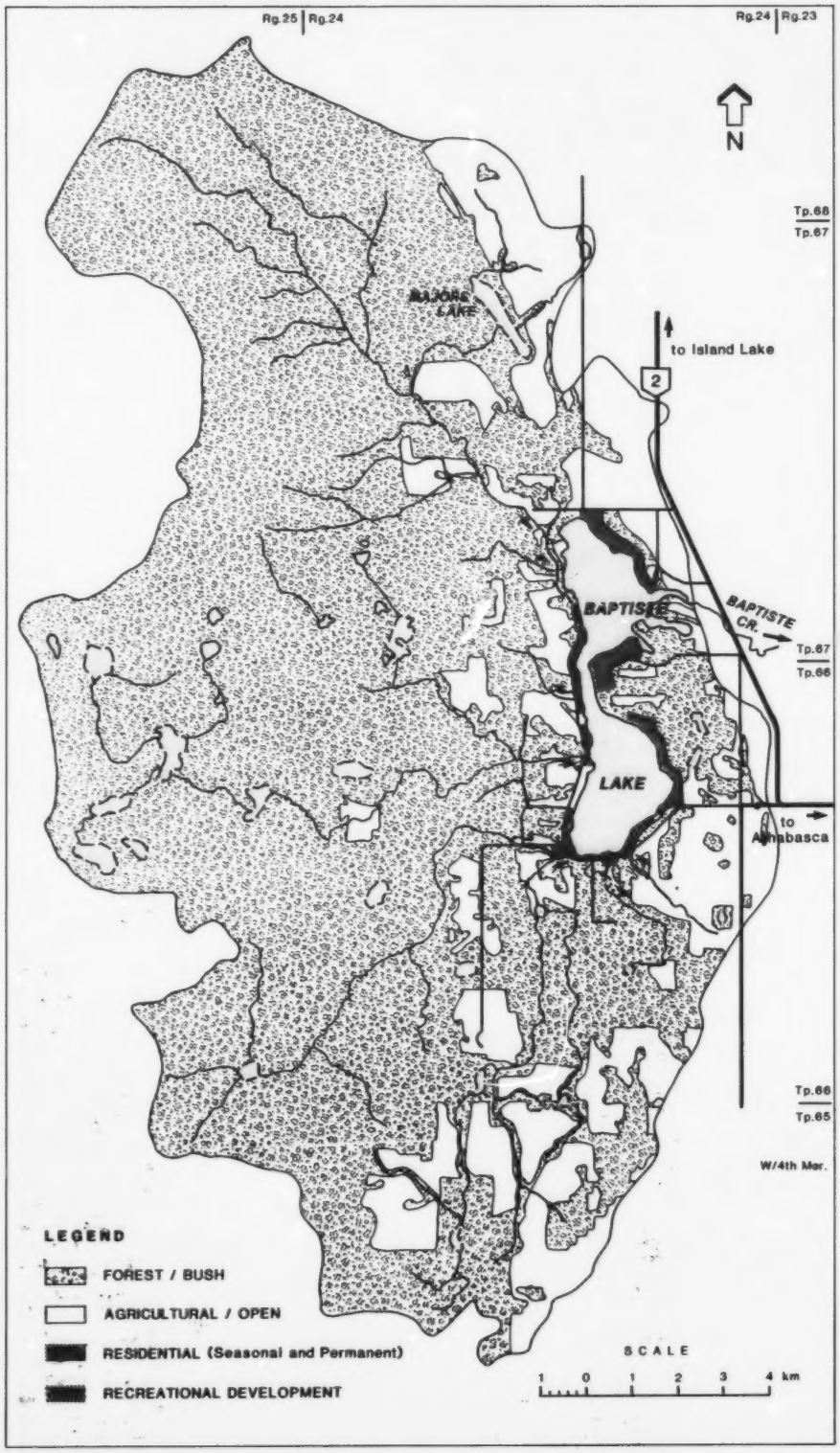
The annual quantity of phosphorus entering Baptiste Lake from external sources is large compared to that for other Alberta lakes. The amount per m^2 of lake surface (the areal load) is high, suggesting that Baptiste Lake is very EUTROPHIC or fertile.

THEORETICAL EXTERNAL PHOSPHORUS SUPPLY*

	kg/year	percentage
SURFACE RUNOFF:		
Agricultural and forested land	2793	82
Urban land	153	5
PRECIPITATION, DUSTFALL	420	12
SEWAGE FROM COTTAGES	25	1
TOTAL	3391	100
AREA LOADING, g/m^2 of lake surface	0.35	

* Source: See footnote 4.

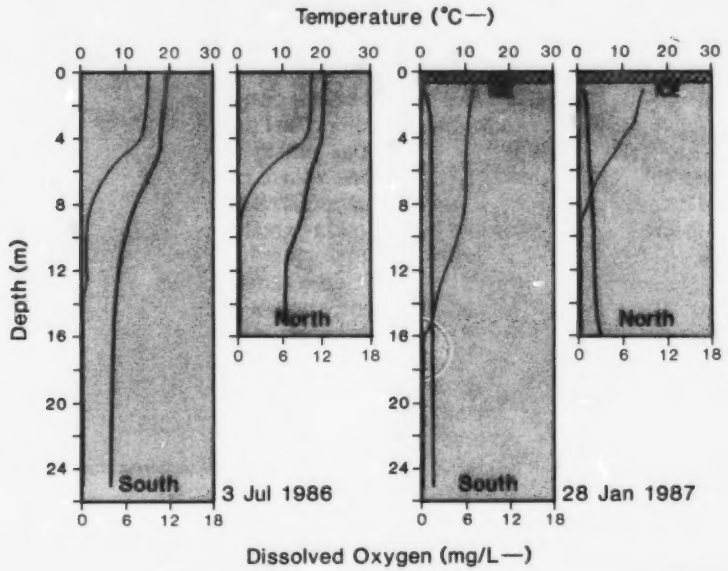
Watershed of Baptiste Lake



Temperature and Dissolved Oxygen

During the summer in Baptiste Lake, a layer of warm water forms over cooler water below. This is shown on the Temperature and Dissolved Oxygen graph for the south basin on 3 July 1986. The curved line between depths of 6 and 8 metres indicates a rapid change in temperature. Even when the surface water is 19°C, the bottom water is only 6°C. This cool layer remains at the bottom of the south basin all summer. Because the cool water is denser than the warm water, there is no circulation of surface water into

Temperature (°C) and Dissolved Oxygen (mg/L) in Baptiste Lake 1986-87



the cool layer, and consequently no replenishment of dissolved oxygen; the graph shows that oxygen was zero below about 14 m. In the north basin, a similar layering process occurs, but because this basin is shallower, strong winds may disrupt the layers and dissolved oxygen is temporarily replenished in the water near the bottom. In the fall, as the surface water cools and becomes more dense, there is less resistance to mixing, and the entire lake circulates from the surface to the bottom, or "turns over". A turnover also occurs in the spring of some years.

In the winter, the formation of ice prevents the replenishment of oxygen in the lake, and oxygen gradually declines as plant material decays and organisms respire. As the graph for 28 January 1987 shows, there was no dissolved oxygen below 16 m in the south basin or below 9 m in the north basin. Although fish would avoid the lower depths of the lake at this time, there is little risk of a major winterkill of fish in Baptiste Lake.

Chemistry

Baptiste Lake is a freshwater lake with low levels of salinity (saltiness) and total dissolved solids. The major ions are bicarbonate (HCO_3) and calcium (Ca) (see the Ionic Diagram). The two basins have similar chemical characteristics. The values shown in the Chemistry Table for Baptiste Lake are similar to those of many lakes in Alberta and are well within the ranges suitable for fish and other aquatic life.

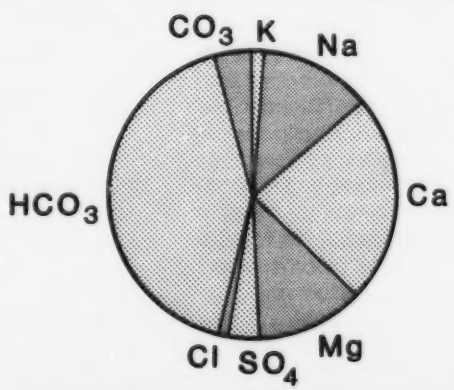
CHEMISTRY averages for May - October, 1986-1987

		SOUTH	NORTH
CONDUCTIVITY	µS/cm*	326	332
pH (RANGE)		7.6 - 8.9	7.6 - 8.9
ALKALINITY	mg/L**	164	166
TOTAL DISSOLVED SOLIDS	mg/L	184	185

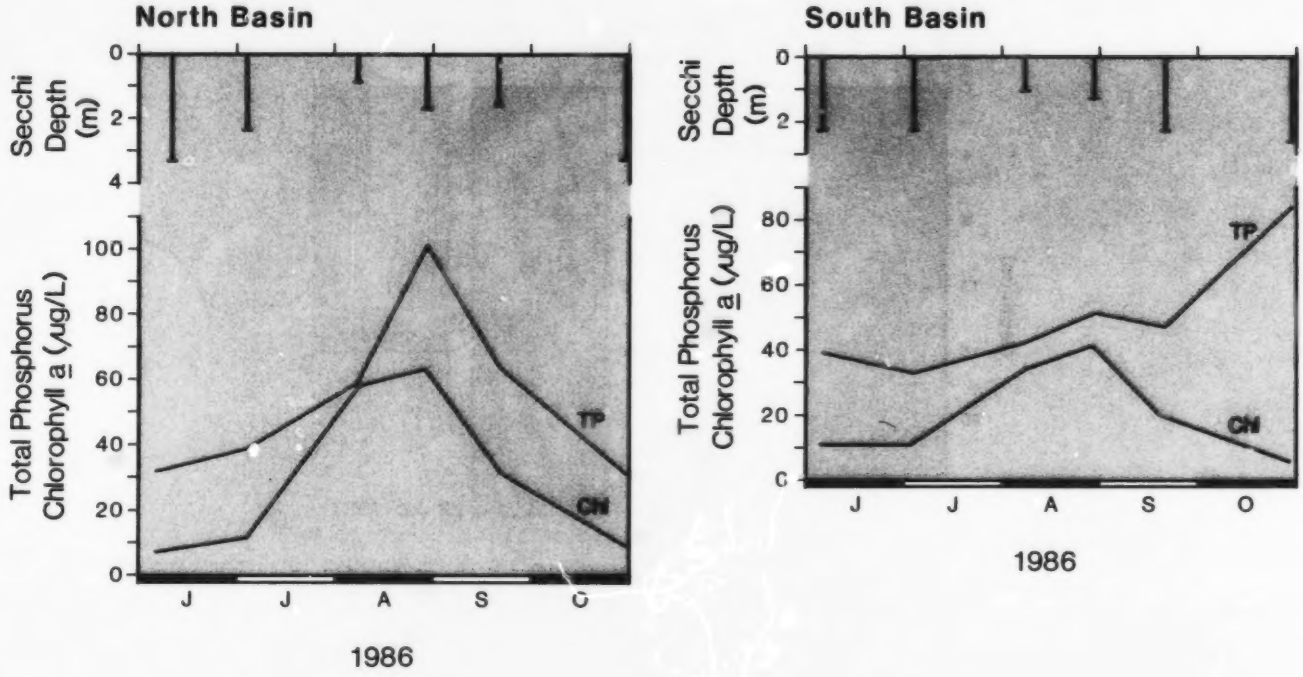
* µS/cm (microsiemens per cm): a measure of the resistance of water and its dissolved salts to electrical flow.

** milligrams per litre = 1/1000 of a gram in a litre of water = parts per million.

IONIC DIAGRAM Relative proportions of Ions in Baptiste Lake 1986-1987



Trophic Status of Baptiste Lake



Algae and Trophic Status

As the summer sun warms the water in Baptiste Lake, large populations of blue-green algae develop. These "blooms" turn the water green. Eventually the algae begin to die, and then unpleasant odors and surface scums are produced. Baptiste Lake has high levels of the plant nutrients phosphorus and nitrogen, which produce such blooms. It is one of the most nutrient-rich of central Alberta's deep recreational lakes.

The Trophic Status graphs show how phosphorus (TP) and chlorophyll a (Chl) changed in the two basins of Baptiste Lake over the summer of 1986. The large peaks of chlorophyll (a measure of the amount of algae) in August indicate when blue-green algal blooms were most intense. In the shallow north basin there is also a peak of phosphorus in August. Much of this phosphorus likely comes from the rich supply stored in the bottom muds of the lake. In the deeper south basin, phosphorus is trapped in the bottom layer until the fall when the whole lake mixes. At that time, phosphorus concentrations in the upper part of the lake increase.

Analyses of long cores taken through thousands of years of accumulated bottom sediment in Baptiste Lake show that the lake has always been fertile.[5] But the clearing of land for agriculture, cottage development and other land uses has probably increased phosphorus loading and therefore the lake's fertility. The watershed is large and nutrients are recycled from the bottom sediment. These factors result in a lake that is green for much of the summer, or very highly eutrophic.

TROPHIC CHARACTERISTICS, average May - October

		SOUTH		NORTH	
		1986	1987	1986	1987
PHOSPHORUS	µg/L*	49	76	54	60
NITROGEN	µg/L	1040	1120	1130	1100
CHLOROPHYLL	µg/L	20	32	30	34
SECCHI TRANSPARENCY	m	1.8	2.0	2.1	1.8

* micrograms per litre = one millionth of a gram in a litre of water = parts per billion.

5. Hickman, M., D.M. Klarer, C. Schweger and T. Habgood. 1978. The paleoenvironmental history of Baptiste Lake, Alberta. Submitted to Alberta Environment, Pollution Control Division, Water Quality Control Branch.

Explanation of Lake Characteristics

PHYSICAL AND HYDROLOGICAL CHARACTERISTICS

Drainage Area or the watershed of a lake is the land surface from which a lake receives its water. As rain water or snowmelt gathers in streams, it picks up soil particles, nutrients and other materials and carries them to the lake.

A study of more than 30 Alberta lakes shows that when drainage areas are large compared to lake areas, (i.e. when the **Drainage Area/Lake Area** ratio is large), lakes have more algae (are more eutrophic) (see TROPHIC CHARACTERISTICS).

Mean Depth is the volume of the lake divided by the surface area. Shallow lakes are often more eutrophic than deeper lakes of a similar surface area.

Inflow is the total volume of water entering the lake in a year. It is related to **Residence Time**, which is the time it would take the inflow to completely fill the empty lake basin.

The **Geodetic Elevation** on the water level graph indicates the level or elevation of the lake above mean sea level.

TEMPERATURE

Alberta lakes show two basic annual patterns of temperature distribution through the water.

Deep lakes, or those protected from strong winds, form layers with the coldest water near the bottom in summer. Because this colder water is denser, it resists mixing into the warmer, lighter, upper layer.

For much of the summer, the bottom portion of water is isolated from the top portion. In spring and fall, these lakes usually mix from top to bottom by wind action as the water becomes uniform in temperature and density. In winter, under ice, the warmest water (about 4°C) is on the bottom, because water is most dense at this temperature.

Shallow lakes mix throughout the summer or layer only temporarily. In winter, the temperature pattern of these lakes is similar to that of deep lakes.

DISSOLVED OXYGEN

Oxygen is essential to the life in lakes. Oxygen from the air dissolves readily in water, especially on windy days when waves break up the lake surface. The photosynthesis of small aquatic plants also supplies a large amount of oxygen to the lake water.

Oxygen is consumed by respiration of animals and plants, and by the decomposition of dead organisms by bacteria. A great deal can be learned about the "health" of a lake by studying its patterns and quantity of oxygen.

Lakes that are unproductive (oligotrophic) will have sufficient oxygen throughout the year at all depths. But as a lake becomes more eutrophic, and increasing quantities of plants and animals respire and decay, the balance shifts towards consumption — especially near the lake bottom where dead organisms accumulate.

In deep productive lakes (see TEMPERATURE), the oxygen in the isolated bottom layer may deplete rapidly, forcing fish to move into the upper layer (fish are stressed when oxygen falls below about 3 mg/L). Fish kills occur when decomposing or respiring algal populations use up the oxygen. In summer, this usually happens when an algal bloom "collapses" or dies suddenly.

SALINITY AND TOTAL DISSOLVED SOLIDS

Lake water contains a multitude of dissolved substances. These can be seen by allowing a dish of lake water to evaporate. If the water is filtered to remove living organisms and other particles, and then allowed to evaporate, the residue is called **Total Dissolved Solids**.

The ions* that make up most of this residue can be measured individually. The **Ionic Diagram** presents all of the major ions in a lake in proportion to each other. The salinity or saltiness of the water is indicated by its **conductivity**. Water that is low in conductivity (salinity) conducts electricity poorly.

Salinity is controlled by the types of rock or soil in the watershed and by the amount of evaporation relative to precipitation. Lakes of high salinity, such as many of those found in southeastern Alberta, have fewer species of plants and animals than freshwater lakes; many are too saline to support fish.

* Ions: Chemical form in water of constituents such as sodium and carbonate.

pH AND ALKALINITY

The **pH** of lake water refers to its concentration of hydrogen ions on a scale that runs from 0 (extremely acidic) to 14 (extremely alkaline). A pH of 7 is neutral - neither acidic nor alkaline.

Most Alberta lakes fall between pH 6 to 9, with the majority on the alkaline side. **Alkalinity** refers to the capacity of water to neutralize an acid, and is a measure of the alkaline materials present in the water.

Alberta lakes that were formed in sedimentary bedrock have a large capacity to neutralize acids entering them, such as from acid rain.

THEORETICAL PHOSPHORUS SUPPLY

Lake scientists know that for most lakes, the amount of algae in the water is related directly to the amount of phosphorus. This is because phosphorus is usually in shortest supply relative to all the nutrients that lake plants need. When it runs out, the algal population can no longer increase. A larger phosphorus supply usually results in more algae.

Based on studies from all over North America, the quantity of phosphorus contributed by a hectare of forest during runoff is remarkably similar no matter where the lake is located. Similarly, agricultural or cleared land overlying sedimentary bedrock contributes fairly similar quantities of phosphorus per hectare in most lake watersheds. This was confirmed for Alberta by measuring quantities of phosphorus supplied by various land uses in several lake watersheds.

In all studies, the phosphorus supply from cleared or agricultural lake was greater than that from forest, averaging 2 to 5 times more.

The **Theoretical Phosphorus Supply** is estimated by multiplying phosphorus supply factors for each type of land use by the area of that land use, and then summing the products.

Similar factors are used for the supply from precipitation. The supply from sewage is estimated based on a percentage of the total amount that could be generated by cottages and camps on the particular lake.

It might be expected that a large phosphorus supply would produce a eutrophic lake. But the size of the lake is also important. If the total phosphorus supply is divided by the surface area of the lake, the resulting **Areal Loading** figure can be compared with other lakes, and can be used as an indication of trophic status.

TROPHIC CHARACTERISTICS

The word "trophic" literally means nourishment.

Mountain lakes usually are "poorly nourished" or **oligotrophic**. Levels of nutrients such as phosphorus and nitrogen are low, plant life is sparse, and the water is clear. Fish production is low.

On the other end of the scale are well-nourished or fertile lakes called **eutrophic**. In these lakes, aquatic plants, including tiny suspended algae, flourish because the water contains abundant nutrients.

Mesotrophic lakes, those intermediate in fertility, often combine the best features of the other two types.

In some lakes, the nutrient supply is so high that plant growth inhibits certain recreational uses of the lake. Lake users may consider such a lake to have poor water quality. One of the purposes in studying lakes is to determine whether fertility is increasing.

There are several ways to measure a lake's fertility or **Trophic Status**.

Phosphorus and **nitrogen** can be measured directly. Phosphorus in lakes of the Boreal Forest/Parkland areas of Alberta ranges between 10 and 200 micrograms per litre* (μg/L) (oligotrophic to highly eutrophic), and nitrogen ranges between 500 and 3500 μg/L.

Transparency of the water declines as a lake becomes more fertile. It is measured with a black and white plate called a **Secchi Disk**, which is lowered through the water on a line marked at metre intervals. The depth at which it can no longer be seen is the **Secchi Transparency**.

The quantity of algae in the water can be determined by measuring its content of **Chlorophyll a**, the green photosynthetic pigment.

* equivalent to parts per billion

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